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ABSTRACT

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A Comparison of the Effect of Single-Sex and Coeducational Schooling Arrangements on the Self-esteem and Mathematics Achievement of Adolescent Females

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Abstract

Coeducation has been nearly universal in the public schools of the United States during the 20th Century. Research conducted in the last decade has questioned the effectiveness of coed schooling with regard the self-esteem and mathematics achievement of adolescent females. Early research reported that single-sex schools where superior to coeducational schools, yielding higher levels of achievement and a greater sense of self-efficacy. More recent research challenges the methods and interpretation of earlier findings. Studies of student performance in single-sex schools lessens the school effect, attributing gains to family background factors. Current findings do not totally dismiss school effects as class size and curriculum are seen as important factors effecting female student achievement. Analysis of single-sex classes within coeducational schools reveals improved locus-of-control and more positive feelings for mathematics with modest improvements in mathematics achievement. The literature indicates that a sex segregated school environment is not the most critical variable effecting the mathematics achievement of adolescent females.

For the better part of the 20th Century, public schools in the United States have been coeducational. The movement away from single-sex schools by the late 1800's was prompted more by economic concerns rather than pedagogical research. The cost of maintaining dual school systems for boys and girls simply became prohibitive for most school systems. Coeducation became accepted as the most practical, and cost effective, means to achieve the aim of providing a more advanced education for both male and female youths. Coeducational public schooling became the norm as social and economic segregation of the sexes became common practice in the workplace (Epstein, 1988). Coeducation in the public schools, on the surface, seemed to defy social norms. Economic concerns were displaced in the 1960's and 1970's by a wave of feminist activism. Feminist demanded equality in educational access for female students. They argued that in order for women to achieve equality in society they must compete with men economically and politically. The means to equality, they believed, begins with equal educational opportunity. Still others claimed that single-sex schooling was an anachronism; a barrier to successful cross-sex socialization as separation inhibits understanding and respect between the two genders (Block, 1984).

In the United States, the trend toward coeducation had a dramatic impact on Catholic schools, which had traditionally been single-sex. In the late 1950's the Catholic Church reiterated its belief that secondary school coeducation was harmful to students for its promotion of promiscuous behavior and denial of "original sin" (Tyack & Hansot, 1990). In spite of the Church's earlier position, economic considerations forced the merger of many single-sex Catholic schools into coed schools. By 1983 less than half of all Catholic secondary schools were single-sex (Bryk, Lee, & Holland, 1993). The

move away from single-sex schools came at a time when researchers were beginning to document positive effects of single-sex schooling, especially for female students (Oates & Williamson, 1978; Tiball & Kistiasky, 1976.). In spite of these studies, economic and political pressures have forced the closure or merger of more single-sex schools.

Education research, when exposed to the light of the popular press, sometimes produces interesting outcomes. The national obsession with math scores has mingled with a resurgence of interest in single-sex schools. This union has spurred research and public debate into the effect of single-sex schools on the self-esteem and academic achievement of female students. Critics of coeducation maintain that coed schooling has no evidence to support its effectiveness. Among its shortcomings they argue, that coed schools promote the values of an adolescent subculture, and perpetuate gender-bias against female students. In his book *The Adolescent Society*, James Coleman claimed that coeducational school arrangements and the proximity of adolescent boys and girls creates an environment where social concerns of dating and popularity outweigh academic achievement (1963). Goodland's studies echoed Coleman's claims, he found that coeducational schools where more likely to promote popularity based upon attributes of physical attractiveness for girls and athletic prowess for boys (1985). Catholic single-sex schools, it is argued, reduce the social distractions, common during adolescence; enabling students to focus on academic success (Riordan, 1985). A more disturbing outcome associated with the coeducation is the prevalence of sexual harassment. A broad definition of harassment includes behaviors ranging from name calling to forced sexual contact. According to a 1991 Harris poll of 1,600 female students in grades 8 through 12, 62 % reported at least one incident of harassment

(Mann, 1994). Advocates argue that single-sex school environments virtually eliminate such incidences.

The emergence of a gender gap in math scores in secondary school has led some critics to charge public schools (i.e. coeducational) with reflecting the gender bias embedded within our culture. Annual reports of the nation's performance on standardized achievement tests have revealed that female students typically trail male students in tests of mathematics and science. The gap is most pronounced on the Scholastic Aptitude Test of Mathematics (SAT-M), on this measure girls scores are 33-59 points below the scores of boys (U.S. Department of Education, 1996). Similar differences appear on the American College Test, average math scores for males are consistently higher than those of females (ACT High School Profile Report, 1996). Interestingly, these results are not found prior to secondary school. The National Association of Educational Progress conducts tests of academic progress beginning in elementary school. NAEP findings on math scores reveal no discernible difference between the scores of girls and boys prior to age thirteen. From age thirteen through age seventeen, however, female student scores trail males by 5-20 points (Bae & Smith, 1997).

Carol Shakeshaft contends that schools are structured to satisfy the needs of male students. She maintains that the curriculum, instructional methods, and teacher attitudes all conspire to hinder the achievement of female students. She also contends that even though girls mature earlier and reading readiness occurs before boys, schools teach skills on a timeline that caters to boy's maturation (1987). School critics who take this line point to standardized test scores as evidence of inequities in the education boys and girls receive from public, coeducational, schools.

The charges of gender bias gained popular attention in the early 1990's. The American Association of University Women's (AAUW) 1990 report, *How Schools Shortchange Girls,* captured a great deal of media attention and raised public awareness on gender bias in public schools. The report, based on a review of over one-thousand publications on girls and education, concluded that gender bias is widespread in public schools. In addition, the report alleged that this bias, in large part, was damaging to the psychological development and academic achievement of female students.

David and Myra Sadker's have conducted a series of studies examining the interaction between students and teachers. The findings of their qualitative studies published in *Failing at Fairness: How American Schools Cheat Girls* reveal differences in the way boys and girls behave in class and how teachers interact with students of different gender. In their observations of primary and secondary classrooms they found that male students displayed a heightened level of activity in the classroom compared to female students. This was exemplified by boys monopolizing teacher attention both positively and negatively by calling out answers and disrupting class. Girls, they observed, are less physically active in class. This was demonstrated as girls being more likely to wait with hands raised to be called on before answering in class. They also noted that secondary school age boys are quick to respond to questions, constructing their answers while responding. Girls, on the other hand, seemed more introspective and refrained from answering until they had constructed their responses fully. Boys, they feel, compete to be the first to answer in class whether they have the answer or not. As a result, the Sadkers observed, girls are overlooked as teachers called on boys at a ratio of 4 to 1 over girls (1994). Researchers have noted that teachers may misattribute the

deliberate thinking style of female students to lack of preparation (Sandler, Silverberg, & Hall, 1996).

The AAUW Report that fueled part of the debate on bias in coed schools is not without its critics. Since its publication in 1991, scholars and journalist have questioned its motives and the reliability of the data used to support claims that coeducation is harmful to female students. The study was conducted under contract by the Center for Research on Women at Wellesly College, a women's college. Some may have perceived the report as an attempt to promote increased enrollment in all-girl schools. Critics have charged that the survey relies too heavily on self-report inventories. The five response scale used has a tendency to lead respondents toward extreme answers of "never" and "always" (Schmidt, 1994). Others have charged that the evidence used in the AAUW study relied on out of date research and unpublished works not subjected to critical review (Kramer, 1992). Caution should also be taken when using the data collected in observational studies like those conducted by the Sadkers. Qualitative studies are highly susceptible to subjective interpretation of events observed by the researcher. This is especially true if the researcher has certain expectations regarding the outcome of the study, such bias cannot be totally eliminated.

The findings of these studies and many others like them, in spite of their drawbacks, have stirred interest in single-sex schools as a way of providing female students with a bias-free educational experience. Social critics of coeducation have argued that coeducational schools function to socialize young men and women into unequal social and professional roles found in our gender stratified society. Proponents of single-sex schooling maintain that such learning environments allow female students

to flourish in a climate that caters to a female's cooperative style of learning. They contend that in single-sex schools they are free of the cultural stereotypes that discourage females in their pursuit of math and science. Psychologically, female students are free of the social distractions associated with rating and dating found in coed schools (Mann, 1994). The promise made by many single-sex schools is well females capable of reaching their full academic potential.

Questions remain. Does a single-sex school environment have an effect on the self-esteem and academic achievement of female secondary school students? Is the effect a positive one? Can other variables better explain the effects? Are there qualities in single-sex schools that can be applied in the public sector to improve female outcomes? This paper will review the evidence for and against single-sex schools and present ideas on improvements within coeducational coed with respect to the needs of female students.

Supporters of single-sex schooling have taken the work of Lee and her colleagues as evidence that single-sex schools produce positive outcomes for female students. In 1986 Lee and Bryk examined single-sex and coeducational Catholic secondary schools from the High School and Beyond longitudinal study (HS&B). Comparisons where made with Catholic schools because they were the only school configuration in the HS&B sample that had both single-sex and coeducational schools in large enough numbers to provide an adequate sample size. Based upon this analysis the researchers claimed that single-sex educational environments where superior to coed schools, especially for female students. Among the advantages reported. Female students are more academically oriented than coed peers and take more advanced mathematics and science courses. Psychological effects include less stereotypical sex-role attitude and higher

locus-of-control for girls enrolled in single-sex institutions. Psychological benefits were exemplified by female subjects reporting greater interest in nontraditional college majors and/or careers as well as a greater sense of self efficacy with regard to academic accomplishments. The researchers maintain that the effects are significant, with over half of the variation being attributed to the single-sex school environment, with sufficient controls for family background factored (Lee & Bryk, 1986). Similar studies using the HS&B sample yielded similar findings. Female students enrolled in single-sex schools, Catholic and non-sectarian, outperformed their coed peers in every measure of academic achievement including: course selection, GPA, and standardized test scores (Bauch, 1988).

In a follow-up study Lee and Marks investigated the sustained effects of single-sex schools for female subjects. Almost half of the subjects used in the original 1986 study were used as subjects in the follow-up study. The researchers reported that females who graduated from single-sex Catholic schools were more likely to pursue higher educational aspirations, including post-graduate study. Female respondents also indicated a greater preference for nontraditional majors and career paths compared to their coeducated counterparts. A significant number of the female subjects where mathematics and computer science majors or minors. The researchers assert that these effects are the result of their experiences in a single-sex school environment. They maintain that the positive experiences in single-sex schools helped young women overcome the psychological barriers that hinder academic achievement for women (Lee & Marks, 1990). Similar sustained effects have been found in other studies. Female graduates of single-sex schools, including non-sectarian schools, have higher enrollments

in college mathematics, chemistry, and physics (Kerr, 1991). According to another survey, female graduates from single-sex Catholic schools report greater locus-of-control and a more positive outlook regarding success in college (Campbell & Evans, 1993). The suggestion of these studies is that gender bias in coeducational schools is a hindrance to female students emotionally and academically.

There may be certain qualities exclusive to single-sex schools that foster greater female achievement in mathematics. Data from the 1992 Lee and Marks study reveal striking differences in the staffing of single-sex Catholic schools, Catholic coeducational schools, and public schools. Staffing and school-based curriculum decisions could play a part in the outcomes reported by single-sex schools. All-girl Catholic schools are have a greater number of female administrators, 60 % report having a woman as headmaster or principal. 76 % of the faculty at all-girl Catholic schools is female. Compared to 10 % and 46 %, respectively, for coed Catholic schools. According to a study of private and public school differences, administrators and teachers at private schools reported having more control over curriculum decisions than those in public schools (Baker & Keil, 1996). Proponents of single-sex education for girls maintain that all-girl schools led by women provides students with positive role-models of women in leadership and competence as mathematics and science teachers and administrators. In addition, control of the curriculum allows female administrators and teachers to select methods and materials deemed more suitable for a female student. The result, more positive attitude toward nontraditional subjects such as mathematics, greater confidence, higher achievement , and higher self-esteem. There is evidence that appears to support these claims.

The correlation between achievement and attitudinal variables is well documented. According to Bem, female students are more likely than males to internalize societal expectations and actually change to fit the expectations of others (1987). Female students are also more likely to attribute success to luck or external factors, while internalizing failure (Bem, 1987; Ryack & Peckman, 1987). All-girl schools that hold high academic expectations while utilizing female-centered instructional methods may reverse these attribution patterns found in adolescent females. Studies indicate that teaching female students to attribute success in mathematics to personal effort rather than external factors can reduce math anxiety and increase standardized test scores (Heller & Zeigler, 1994). Research also indicates that confidence in mathematics influences problem solving strategies. Researchers feel that math problem on the SAT-M favor a more intuitive, estimation based problem solving strategy. Female students, Ranked high in math anxiety, tend to rely on more conventional problem solving strategies based on operations and procedure. Researchers found that female students who ranked high in measures of math confidence where more likely to use intuition and estimation to solve advanced math problems, leading to higher SAT-M scores (Gallager & DeLisi, 1994). Single-sex schools may play some part in increasing math confidence in their female students, manifesting itself in higher SAT-M and ACT scores.

Course selection is also cited as a reason behind female math scores. Failure to complete four years of math in high school is cited as a principle reason for the gender gap in SAT-M scores (Hoffer, 1995). In both public and private schools, female enrollment in calculus averages only 35 % (Tocci & Engelhard, 1991). With regard to

achievement in mathematics, single-sex schools (Catholic and independent) that rank college preparation as their primary aim require students to complete higher level math courses, producing higher results on standardized test of mathematics.

The reports claiming superiority of single-sex schools with regard to female achievement and self-esteem has captured the attention of education policy-makers in the public sector. However, scientific scrutiny has raised some questions regarding the validity of earlier claims that the single-sex environment is the primary variable explaining the academic success of female students. Much of the criticism has been leveled against studies that rely on the High School and Beyond data set, including the studies by Lee and Bryk in 1986 and the follow up with Marks in 1990.

The High School and Beyond study (HS&B) , sponsored by the national Center for Educational Statistics, sample consisted of 1,015 high schools; from each school 36 sophomores and 36 seniors were randomly surveyed. The chief criticism leveled against Lee and others using this data set is the inability to differentiate between true school effects and preexisting differences. Marsh contends that Lee and Bryk's control for background variables such as family income fails to address the problem inherent with comparing the effect of high school environment by analyzing scores of 10^{th} and 12^{th} grade students (Marsh, 1989). In order to assess the actual effect of single-sex schools on student outcomes in 10^{th} and 12^{th} grade one must control for differences that existed before entering high school.

Utilizing the same HS&B sample as Lee and Bryk in 1986, Marsh controlled for seventeen background variables including: SES, ethnicity, grades repeated, number of parents in the home, and college expectations. He assumed that these selected variables

would adequately represent preexisting conditions overlooked in the 1986 study by Lee and Bryk. According to Marsh's findings, compared to coeducational public schools, females in Catholic schools have higher achievement scores. However, these effects are not found in comparisons between single-sex and coed Catholic schools. Marsh argues that the strongest school effect stems from a greater emphasis on academic course selection found in Catholic schools of both configurations (1991). Controlling for family background variables diminished the school effect indicating a weak correlation, if any, between single-sex school environments and positive outcomes for female students.

In an effort to end the controversy over the use of the HS&B data, LePore and Warren used data collected for the National Educational Longitudinal Study of 1988 (NELS:88). The researchers maintain that the NELS:88 data set is superior to the HSB data for several reasons. First, the NELS data followed an 8th grade cohort over a six year period. This allows for the collection and control of preexisting variables, unlike the HSB data collected over a two year period during high school. Second, the NELS data set contains a usable random sample of 25,0000 students from 1000 schools both public and private. Regression analysis in some studies using the HS&B data reduced the usable sample to less than 31 schools. The larger NELS:88 sample size provided more subjects enrolled in a variety of private sector school arrangements. Finally, the NELS survey measured a variety of variables including family background, peer relationships, school structure, student achievement, and student attitudes (LePore & Warren, 1997).

Using the NELS:88 data set, LePore and Warren reported remarkably different findings than those of Lee and Bryk in 1986. The researchers replicated the earlier study

and asked the same questions. They found that boys in single-sex Catholic schools did have higher achievement scores than boys in coed Catholic schools but the effect was barely significant when family background variables were factored. Analysis of gain scores, comparing 8th, 10th and 12th grade showed no significance for either male or female students. Consistency in the scores would indicate that school environment has no effect on achievement. One could expect increased gain scores with each passing year in the single-sex school environment, if the school environment had a significant effect on academic achievement. Similar results were found in psychological measures. Analysis of self-report data found no evidence that the single-sex environment improved self-esteem or locus-of-control in female students (1997).

Smaller studies using different samples have also contradicted claims that the academic achievements reported by single-sex schools are entirely the result of the school variable. Analysis of achievement test scores using the Australian cohort of the Second International Science Study revealed that school environment could account for only 19 % of the variance in female science scores. With regard to physics scores, students in single-sex schools had scores higher than those in coeducational schools. However, researchers reported 41 % of the variance could be explained by family background variables (Young & Frazier, 1992).

Some may argue that any studies of achievement between private and public sector schools are invalid due to nonequivalent group comparison, regardless of statistical controls for family background. New Zealand schools have provided researchers with the ability to compare single-sex and coeducational schools, as both arrangements exist in the public sector. In a small study of the effects of a school merger

from single-sex to coed the outcome lent support to both sides of the debate. The researchers conducted a ten year study following the merger and found that academic achievement declined for both male and female students. Regarding psychological adjustment and self-concept females showed no change, while males showed a slight improvement in self-concept (Smith, 1995). The findings on psychological measures contradict those claims by Riordan that single-sex schools foster positive self-esteem and bolster the confidence of female graduates (1990). If the single-sex environment had a positive effect on female students the merger results should have shown a decline in female scores of self-confidence. Using data from the Progress at School study researchers analyzed data on 5,000 New Zealand students from 37 schools. Harker and Nash found that school effect accounted for only 5 % of the variance in female achievement scores (1997). Once again researchers controlled for background variables indicating that factors such as: family income levels and parent's education are better predictors of student achievement than the type of school attended.

Researchers critical of the claims that single-sex schools are superior learning environments for girls often cite selectivity as a primary reason why single-sex private schools report higher achievement test scores as well as higher ratings with respect to student attitudes toward school. In this case, selectivity not only refers to parent's option to choose a particular school but also a school's option to deny admission to particular students. The ability to pick and choose students gives private schools (single-sex, coed, Catholic or non-sectarian) the ability to create a student body distinctively different from that of public schools. Noticeably absent are ethnic minorities, lower income, and special needs students. Single-sex secondary schools are able to boast smaller class size,

lower drop-out rates and higher levels of college attendance. In spite of the fact that graduation requirements are quite similar for single-sex Catholic schools, coeducational Catholic schools, and public schools, the public perceives private schools of all types as promoting higher academic standards (Anderson & Resnick, 1997).

The reputation of a school, be it public, private, coed or single-sex draws parents seeking whatever it is a school is offering. Among Catholic schools in the United States, single-sex schools are perceived as being more exclusive, traditional, and as offering a rigorous classical curriculum. Using data from the HS&B study and National Longitudinal Study of 1972, Lee and Marks found that parents selecting single-sex schools for their daughters chose schools primarily for the single-sex environment. Academic reputation and class size were secondary concerns (1992). The study implies that parents of daughters chose single-sex schools for traditional reasons over academic. In this case parents seem most concerned with protecting daughters from the distractions of the youth subculture said to prevail in coeducational schools. These findings counter single-sex school advocates who argue that parents should send their daughters to single-sex schools to empower them to overcome the obstacles faced in a sexist society. I would contend that Lee and Marks findings are flawed because of the use of the NLS data from 1972. Parental attitudes regarding women's roles in society and the expectations held for a daughter's independence have changed greatly in the last twenty-five years. I would further argue that a survey of parents who now send their daughters to single-sex schools would reveal academic reasons as the primary reason for their choice.

Cross-cultural studies reveal that the effects of single-sex schools elsewhere differ from those found in the United States. Comparisons between single-sex schools and

coeducational schools in Belgium, Japan, New Zealand, and Thailand reveal that the role of single-sex schools in the national context plays a part in achievement outcomes. Researchers found that in countries where single-sex and coed school enrollment was approximately equal (Belgium and New Zealand), single-sex schools showed no advantage in academic achievement. In Thailand, single-sex school enrollment is less than 9 % of the student population; there single-sex schools appear to yield higher achievement scores for female students. The effect seen in the Thai single-sex schools is likely to be the product of selectivity on the part of parents and schools. In Japan, however, single-sex schools for girls serve as finishing schools for traditional Japanese women. The effect on academic achievement is negative compared to the highly competitive Japanese coed public schools (Baker, Riordan, & Shaub, 1995). The perceptions that the public has of a school, and its purpose, draw parents to select schools that satisfy their demands. Therefore, parental involvement and expectations, rather than school environment, may be more critical factors in predicting female academic outcomes.

The Lee and Marks survey does provide insight into other variables, other than the school environment, that could better explain why female students in single-sex schools have higher scores on achievement tests, especially in mathematics. In their study the researchers report that for all-girl schools, parents paid an average tuition of 7,000 dollars annually. Of the families surveyed less than 11 % received some form of financial aid to help with tuition expenses. The study found minority enrollment at less than 8 %. These findings were similar to those of Catholic coeducational schools (Lee & Marks, 1992). Similar demographics have been reported in other studies of school

demographics (Bringaham,1993 ; Anderson and Resnick, 1997). The picture that emerges is one of parents who have devoted a great deal of financial resources and time to their daughter's education. The quality of a parental involvement in their child's education is positively correlated with higher academic achievement (Bempechat, 1990; Snipes, Blendinger, & Jones, 1995). Family income and educational attainment are also positively correlated with academic achievement of children. Low income and ethnic status are cited as significant risk factors for lowered achievement in mathematics and reading (Pungello, 1996). The data from the Lee and Marks study reveal that 89 % of the respondents who send their daughters to single-sex schools have the means to pay tuition for attendance. It is a safe assumption that these parents, and those receiving aid, closely monitor their daughter's academic progress and work with their children to insure success and a return on their investment.

Demographic changes in Catholic schools since 1980, when the HS&B study was conducted, may also explain why later studies do not replicate the findings of Lee and Bryk. From 1982 to 1992 the number of Catholic schools has declined by 27 %; more single-sex Catholic schools have closed, merged, or gone coeducational. The number of non-Catholic students attending Catholic schools has increased by 4 % and the number of non-white students has increased by 7 % in the same time frame (Brigham, 1993). These changes are probably the response of Catholic schools to maintain enrollments in the face of growing operating costs. In effect Catholic schools, single-sex and coeducational have become less selective in the last fifteen years. Analysis of more recent demographic data on Catholic school students and their family backgrounds may appear to be more like those of a suburban public schools. Future comparisons between

single-sex and coeducational schools may be difficult to conduct due to the diminishing sample of schools to study. These demographic changes may been seen as support for the hypothesis that female academic achievement scores at single-sex schools are probably the product of family background variables and not as much the school environment. The single-sex Catholic schools that weather the current economic pressures may be either subsidized by a diocese as a compensatory school in lower income communities or exclusive academies underwritten by wealthy alumni. In either case background variables may make future comparisons unreliable.

Changes within the coed schools, private and public may also explain why earlier findings regarding single-sex advantages seem to have diminished in later studies. Since the 1980's scores of reports, studies and books have been published documenting the problem of gender-bias in schools, most notably in the public schools. The charges range from male dominance in administration to classroom methods that promote a competitive male learning style to curriculum materials that ignore the roles of women in history and science. It is naïve to think that coeducational schools, especially in the public sector, have purged themselves of all vestiges of sexism and bias. However, studies indicate that improvements are being made. Changes in the curriculum as well as alternative class structures are being implemented to help assure that coeducational schools are more sensitive to the needs of female students (Campbell and Sanders, 1997).

The literature suggests that any achievement or psychological advantages reported for females attending single-sex schools (Catholic or non-sectarian) are most likely the product of family background rather than school variables. Variables such as socioeconomic status, parent's educational attainment, and ethnicity are well

documented as powerful influences on a child's well being and academic success. However, none of the studies used in this report to argue against the effectiveness in single-sex schools could statistically eliminate the school effect entirely. Studies indicate that the school effect on female self-esteem and achievement could be as little as 5% or as much as 20% (Marsh, 1990; Young & Frazier, 1992). What could coeducational schools, public or private, learn from single-sex schools to improve the mathematics achievement and self-esteem of their female students?

Analysis of the literature should strike a cautionary note for those eager improve the educational experience of female students by establishing single-sex public schools. Currently single-sex pilot programs are being launched in several states, including California. Small class sizes, school selectivity, parental expectations, and student socioeconomic status are significant variables explaining higher achievement among female students enrolled in single-sex schools. Large scale implementation of single-sex schools in the public sector would, most likely, nullify those variables that best explain the success of private or single-sex schooling. Public sector single-sex schools are facing legal and political challenges, The National Organization for Women has argued in New York and California that single-sex schools promote gender stereotyping and perpetuate the myth that girls cannot compete with boys academically. The New York office of The American Civil Liberties Union has charged that sex segregation in the public schools is equal to the racial segregation that existed in the fifties and sixties (Ravitch, 1996). The greatest challenge to the trend toward tax supported single-sex schools will probably come from the federal government. Title IX of the Educational Amendments of 1972 prohibits single-sex classrooms in schools receiving federal aid.

Currently the only exception is segregation for the purpose of sex education. Single-sex public schools in Baltimore have skirted the federal ruling by arguing that all-girl schools do not prohibit boys from attending (Walsh, 1996).

It is possible, however, to experience the same selectivity effects in voluntary single-sex public schools or sex segregated classes as those that have been found among the private schools. Those parents of public school students who are active in their child's education would be more likely to enroll their children in the alternative single-sex schools. This could result in the creation of classes filled with the children of politically savvy parents who are able to garner additional resources for their children's school. Improved mathematics achievement scores for female students, may quickly be attributed to the single-sex arrangement; other variables such as parental involvement and selectivity may be overlooked in the assessment of the school's success. The result, sweeping policy changes at the state and/or local level based upon incomplete analysis of the data.

A less sweeping approach to the improving math achievement among female students may be found in single-sex math classes and improved teacher training in gender-based instructional methods. Several school districts across the country have experimented with the formation of single-sex classes in math and science. Several variations exist; the most common being voluntary all-girl or all-boy mathematics classes taught by a teacher of the same sex as the students in the class. Study the results have been mixed. Gierl's study of sex-segregated physics classes revealed that female students had a more positive attitude toward physics class. Females from the all-girl classes performed equally to males and outperformed females in coed physics classes

(1994). In an Australian study, female students and their parents both reported positive experiences after enrolling in sex-segregated mathematics classes. However, these attitudes did not influence the choice of female students to take more advanced mathematics in the future. The study also showed no significant increase in math scores for girls in the sex-segregated classes (Leder & Forgasz, 1994). Another Australian study showed no difference in mathematics achievement scores for girls in sex-segregated classes (Marsh & Rowe, 1996). The positive effects of single-sex mathematics classes are most often seen in the attitudes of girls enrolled in the segregated classes. In a survey comparing the attitudes of girl after taking a single-sex math or coed math class, subjects in single-sex classes reported being able to answer questions, having time to think about problems more than their peers in coed classes. However, achievement differences were considered marginally significant (Streitmatter, 1997). Long term study of single-sex classes will need to be conducted to ascertain their actual effect. Reports of more positive feelings regarding math lends support to the claims made by single-sex school advocates that male students dominate classroom exchanges and divert teacher's time away from female students. Positive feelings about a class are not likely to translate into higher achievement overnight. A longitudinal study beginning in primary school continuing into secondary grades is needed to provide data for a more thorough analysis. Critics have charged that separating classes by sex, regardless of the reason, may have undesired consequences. Sex segregated public schools or classes may perpetuate the stereotype that female students cannot compete in "real" math and science classes.

Reform minded critics argue that changes within the public schools offer a solution to the problem of female mathematics achievement without the legal challenges and political challenges. Recognizing the problem as one of course avoidance, lack of confidence, and unbalanced instruction Karen Karp and Charol Shakeshaft have offered several suggestions geared toward improving the quality of math education for female students in the public schools. They suggest a comprehensive approach to math instruction starting with hiring math specialist to guide teachers in effective instructional methods. They believe mathematics activities should emphasize cooperative learning and minimize the emphasis on speed in solving problems. In an effort to reduce course avoidance, they feel guidance counselors should provide counseling to prepare female students for higher level math courses. Counselors would also monitor the progress of female math students and avert the possibility of leaving courses as the workload increases. Finally they believe parents should be encouraged to monitor their daughter's progress in mathematics (1997). Such an approach could have a positive effect on the achievement of female students. However, critics would be quick to ask why the same allocation of resources was not being used to address other problems of achievement and self-esteem in other students at greater risk.

Crucial to the reform of the educational system is proper training of pre-service teachers and those already in the classroom. Teachers, often unintentionally, bring the biases and stereotypes of the larger society into their classrooms. Internship programs often expose prospective teachers to models that exercise both deliberate and unintentional gender bias (Bailey, Scantlebury & Letts, 1990). Pre-service teachers, as well as experienced teachers, could benefit from training in identifying forms of gender

bias. Specific training should focus on techniques to ensure girls and boys are given equal opportunity to participate in class. Training should also include gender based communications skills to help teachers properly interpret nonverbal communication of their students. Perhaps one of the greatest needs is for teachers and parents to realize that boys and girls learn and think in different ways. Acceptance of these differences requires that boards of education begin overhauling the curriculum and colleges of education supply teachers with methods needed to reach different learners. Fresh thinking will be necessary for reform; parents, teachers and students must learn to avoid thinking of different as deficient. Currently pre-service teachers receive some methods training in cooperative learning techniques. Survey results reveal that many college methods professors are uninformed on the issue of gender bias in the classroom, however, there is interest in addressing the problem. In a survey of one hundred AACTE member institutions, 83 % of the respondents believed that gender equity should be taught in teacher education programs (Cambell & Sanders, 1997). Teacher training appears to be the best starting point with regard to changing stereotypical attitudes surrounding female achievement in mathematics and science.

Identifying the variables that are associated with a student's self-esteem and academic achievement is a formidable task; thousands of studies have tested the significance of hundreds of variables. The individuality of each student further complicates the task, as he or she is affected by these variables differently based on a multitude of personal factors, including gender. With regard to the differences in math scores between male and female students, several explanations have been offered from a variety of disciplines. The contention that bias in coed schools is at fault is loosing

support as that research is subjected to greater scrutiny. The AAUW, whose report fueled this debate has issued another study diminishing the positive effect of single-sex schools on female outcomes. In their most recent report *Separated by Sex: A Critical Look at Single-sex Education for Girls,* the AAUW maintains that their is no evidence that single-sex schools or single-sex classes work better for girls than coeducational arrangements. The report reinforces findings that attribute differences in academic achievement to a variety of other factors. The report cites smaller schools, small class sizes, equitable teaching practices, and a challenging curriculum as factors that most likely improve student outcomes for both boys and girls. There remains, however, concern that the nation's school systems are not providing an equitable learning environment for all of its students. Whether this inequity is a contributing factor in lowered SAT scores for female students is still open to debate. Female students in coed schools appear to be discouraged from taking advanced math and science courses. The reasons are arguable but the consequences are not. Attention should be directed at why girls choose not to pursue math and science. By the senior year of high school, most female students have opted not to take calculus and physics, a choice reflected in SAT-M scores as much as 50 points behind those of male students. Consequently, this limits choices of college major away from engineering or computer science.

Some may question why so much attention has been given to girls' mathematics scores in light of the strides made by female students with regard to graduation and college attendance. From a socioeconomic perspective, the answer is clear. The sexual division of labor has changed dramatically since the 1950's. The concept of "separate spheres" that kept women at home while the husband toiled as the breadwinner is a thing

of the past for many families. Today dual-income families are the norm and single-parent homes lead by women continues to rise (Fuchs, 1990). Furthermore, the job market has become increasingly technical, requiring more people trained in mathematics, science, and engineering. Women only earn 30 % of the bachelors degrees in these fields, but comprise 50 % of the college population (Weld, 1997). If one of the aims of schools is preparing students for work, they must help female students develop the skills necessary to compete in this job market. This includes improving PSAT and SAT-M scores as they are often used as the criterion for awarding scholarships and granting entry into college.

The structural features of single-sex schools: small class size and local control over curriculum and policy decisions could be implemented in public schools to bring about improvement for all students. While some systematic differences exist between single-sex, coeducational, public and private schools, however, greater variations exist within each arrangement. Coeducational schools are not perfect, but they do reflect real life. How successful female students are in school does not depend solely on type of school they attend, rather it is related to the abilities, attitudes, and problems they bring to the classroom; the skills and expertise of their teachers and the quality of the learning environment. Assuring these factors are conducive to learning is the joint responsibility of the students, teachers, parents, schools, communities and policy-makers at the federal, state, and local levels.

References

American Association of University Women (1990). Shortchanging girls, shortchanging America: Full data report. Washington, DC: Author.

American Association of University Women (1998). Separated by sex: A critical look at single-sex education for girls. Washington, DC: Author.

ACT High School Profile Report, HS Graduating Class of 1996. A publication of the American College Testing Program—Educational Services Division, Iowa City, IA.

Anderson, K. M. & Resnick, M. A. (1997). Careful comparisons: Public and private schools in America. East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED 411 611)

Bae, Y., & Smith, T. M. (1996). The condition of education 1996 Issues in focus: Women in mathematics and science [On-line]. Available: http://www.ed.gov/NCES/pubs /ce/C97005.html

Bailey, B. L., Scanntlebury, K., & Letts, W. J. (1997). It's not my style: Using disclaimers to ignore gender issues in science. Journal of Teacher Education, 48, (1), 29-36.

Baker, M. H. & Keil, C.T. (1996). How different, How similar? Comparing key organizational qualities of American public and private secondary schools. Washington, D.C., U.S. Department of Education, National Center for Educational Statistics, 1996,

Baker, D. P., Riordan, C. & Schaub, M. (1995). The effects of sex-grouped schooling on achievement: The role of the national context. Comparative Education Review, 39, (4), 468-481.

Bauch, P. A., (1988). The differences among single-sex and coeducational high schools. Momentum, 19, 56-58.

Bem, S. L. (1987). Gender schema theory and the romantic tradition. In Shaver, P. & Hendrick, C. (Eds.), Sex and Gender. Newbury Park: Sage.

Bempechat, J. (1990). The role of parental involvement in children's academic achievement: A review of the literature, Trends and issues no. 14. New York, NY: ERIC Clearinghouse on Urban Education: Institute for Urban and Minority Education, (ERIC Document Reproduction Service No. 322 285).

Block, J. H. (1984). Sex role identity and ego development. San Francisco: Jossey-Bass.

Bringham, F. H., Jr. (1993). United States Catholic elementary and secondary schools 1992-1993: Annual statistical report on schools, enrollment, and staffing. Washington DC: National Catholic Education Association.

Bryk, A. S., Lee, V. E., & Holland, P. B. (1993). Catholic schools and the common good. Cambridge, MA: Harvard University Press.

Campbell, K. T. & Evans, C. (1993, November). Gender issues and the math/science curricula: Effects on females. Paper presented at the annual meeting of The Mid-South Educational Research Association, New Orleans, LA.

Cambell, P. B. & Sanders, J. (1997). Uniformed but interested: Findings of a national survey on gender equity in preservice teacher education. Journal of Teacher Education, 48, (1), 69-75.

Coleman, J. S. (1963). The adolescent society. New York: Free Press.

Epstein, C. F. (1988). Deceptive distinctions: Sex, gender, and the social order. New Haven, CT: Yale University Press.

Fuchs, V. R. (1990). Women's quest for economic equality. Cambridge, MA: Harvard University Press.

Gallagher, A. M. & DeLisi, R. (1994). Gender differences in scholastic aptitude tests: Mathematics problem solving among high-ability students. Journal of Educational Psychology, 86, (2), 204-211.

Gierl, M. J., Harley, D., & Dunnigan, M. (1994, April). A student's perspective on the intrinsic characteristics of the single-sex physics class. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Goodland, J. I. (1984). A place called school. New York: McGraw- Hill.

Harker, R. & Nash, R. (1997, March). School type and the education of girls: Coed or girls only? Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Heller, K. A. & Ziegler, A. (1996). Gender differences in mathematics and sciences: Can attributional retraining improve the performance of gifted females? Gifted Child Quarterly, 40, (4), 200-210.

Hoffer, T. B., Rasinski, K. A., & Moore, W. (1995) Social background differences in high school mathematics and science coursetaking and achievement: Statistics in brief. (NCES Report No. 95-206). Washington DC: U.S. Department of Education Office of Educational Research and Improvement.

Karp, K. & Shakeshaft, C. (1997). Restructuring schools to math friendly to females. NASSP Bulletin, 81, (586), 84-93.

Kerr, B. A. (1991). Educating gifted girls. In Colnagelo, N. & Davis, G. A. (Eds.), Handbook of Gifted Education. Boston, MA: Allyn and Bacon.

Kramer, R. (1992). Ed School Follies: The Miseducation of American Teachers. Boston: Free Press.

Lee, V. E. & Bryk, A. S. (1986). Effects of single-sex secondary schools on student achievement and attitudes. Journal of Educational Psychology, 78, (5), 381-395.

Lee, V. E. & Marks, H. M. (1990). Sustained effects of the single-sex school experience on attitudes, behaviors and values in college. Journal of Educational Psychology, 82, (3), 578-592.

Lee, V. E. & Marks, H. M. (1992). Who goes where? Choice of single-sex and coeducational independent secondary schools. Sociology of Education, 65, (7), 226-253.

LePore, P. C. & Warren, J. R. (1996, April). The advantages of single-sex Catholic secondary schooling: Selection effects, school effects or "Much ado about nothing". Paper presented at the annual meeting of the American Educational Research Association, New York, NY.

LePore, P. C. & Warren, J. R. (1997). A comparison of single-sex and coeducational catholic secondary schooling: Evidence from the National Educational Longitudinal Study of 1988. American Educational Research Journal, 34, (3). 485-511.

Marsh, H. W. (1991). Public, Catholic single-sex, and Catholic coeducational high schools: Their effects on achievement, affect, and behaviors. American Journal of Education, 41, 320-356.

Marsh, H. W. & Rowe, K. J. (1996). The effects ofsingle-sex and mixed-sex mathematics classes within a coeducational school: A reanalysis and comment. Australian Journal of Education, 40, (2), 147-162.

Mann, J. (1994). The difference: Growing up female in America. New York, NY: Warner Books.

Oates, M. J. & Williamson, S. (1978). Women's colleges and women achievers. Journal of Women in Culture and Society, 3, 795-806.

Perry, W.C. (1996). Gender-based education: Why it works at the middle-school level. NASSP Bulletin, 80, (4), 32-36.

Pugello, E. P. (1996). Environmental risk factors and children's achievement from middle childhood to early adolescence. Developmental Psychology, 31, (4), 755-767.

Ravitch, D. (1996, May 20). The Gender bias myth: Unfounded claims by the American Association of University Women. Forbes, 157, (10), 168.

Riordan, C. (1985). Public and Catholic schooling: The effects of gender contest policy. American Journal of Education, 5, 504-515.

Rothstein, R. (1996). Single-sex school experimentation. [On-line]. Available: http://epn.org/rothstci/ro960117.html

Ryack, D. B. & Peckman, P. (1987). Gender differences in attributions for success and failure situations across subject areas. Journal of Educational Research, 81, 120-125.

Sadker, D., & Sadker, M. (1994). Failing at fairness: How American schools cheat girls. New York, NY: Scribner's

Sandler, B. R., Silverberg, L. A., & Hall, R. M. (1996). The chilly classroom climate: A guide to improve the education of women. Washington DC: National Association of Women in Education.

Shakeshaft, C. (1986). A Gender at Risk. Kappan, 48, (3), 499-503.

Schmidt, P. (1994, September 28). Idea of a 'gender gap' in schools under attack. Education Week on the Web. [On-line]. Available: www.edweek.org/htbin/fastweb?getdoc+view4+ew1994+1

Smith, I. D. (1996, August). The impact of coeducational schooling on student self-concept and achievement. Paper presented at the biennial meeting of the International Society for the Study of Behavioral Development, Quebec, Canada.

Snipes, G. A., Blendinger, J. & Jones, L.T. (1995, November). Principals' perceptions of parental involvement practices in high and low academically achieving elementary schools. Paper presented at the annual meeting of the Mid-South Educational Research Association, Biloxi, MS.

Streitmatter, J. (1997). An exploratory study of risk-taking and attitudes in a girls-only middle school math class. Elementary School Journal, 98, (1), 15-26.

Tiball, M. E. & Kistiakowsky, V. (1976). Baccalaureate origins of American scientists and scholars. Science, 193, 646-652.

Tocci, C. & Engelhard, G. (1991). Achievement, parental support and gender differences in attitudes toward mathematics. Journal of Educational Research, 84, (5), 280-286.

Tyack, D. & Hansot, E. (1990). Learning together: A history of coeducation in American schools. New Haven, CN: Yale University Press.

U.S. Department of Education, National Center for Education Statistics, NAEP 1994 Trends in academic progress., 1996.

Walsh, M. (1996, June 12). Number of single-sex schools on the rise, GAO says. Education Week on the Web. [On-line]. Available: www.edweek.org/htbin/fastweb?getdoc+view4+ew1996+1017+8+wAAA+%26%28.

Weld, J. (1997, February 5). Separate-sex science shortchanges students. Education Week on the Web. [On-line]. Available: http://www.edweek.org/ew/vol-16/19weld.h16

Young, D. J. & Fraser, B. J. (1992, April). Sex differences in science achievement: a multilevel analysis. Paper presented at the Annual Meeting of the American Research Association, San Francisco, CA.